

Palaeontology of the Bagh Beds

Part V. *Ostreina* (i)

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ABSTRACT

In this first ever detailed study of oysters from the Bagh Beds, a new genus *Indostrea*, characterised by small shell, development of chomatal pits all along the margin and absence of radial ornament, and its seven species are described.

1. INTRODUCTION

OUR knowledge about oysters from the Bagh Beds is confined only to the few provisionally identified species mentioned in the lists of Bagh fossils.¹⁻⁷ Even Chiplonkar after studying most of the mega fossils from the Bagh beds had, due to fragmentary conditions of the specimens in his collection, deferred a detailed study of this group of bivalves till more worthwhile material became available. The present communication is, therefore, the first ever report on a systematic study of the Bagh oysters. Results of our study of other Bagh ostreids in our collection, and a detailed discussion on the faunal affinities and the geological horizon which may be assigned to the oyster fauna of Bagh, will appear in a later communication. Here we deal only with the new genus *Indostrea* and its species found till now in these beds.

LOCALITY INDEX

1. Badia $22^{\circ} 21' 50''$; $74^{\circ} 04' 00''$
2. Khadlu 2 km South of Mongra.
3. Mongra $22^{\circ} 00' 38''$; $74^{\circ} 02' 30''$
4. Motichikli $22^{\circ} 21' 00''$; $74^{\circ} 19' 10''$

2. GENERAL REMARKS

Until a full discussion on the oyster fauna of Bagh Beds appears, it may be mentioned that the species described here and even the genus under which they are placed, are all new to science, and would not by themselves give definite evidence about their geological horizon. But as can be seen from the comments in the systematic part of this paper, species apparently allied to them are known to occur in strata ranging between Cenomanian and Maestrichtian. These species occur together in the oyster bed near the top of the Nimar Sandstone and the oyster bed at the top of the Upper Coralline Limestone and thus show a mixture of affinities at both levels at which they occur.

3. SYSTEMATIC DESCRIPTION

Family : Ostreidae Rafinsque 1815
 Subfamily : Ostreinae Rafinsque 1815
 Genus *Indostrea* gen. nov.
 Type species : *Indostrea indica* sp.nov. *Geno-holotype* No. Bad 9/73 (*vide infra*).

DIAGNOSIS: Shell spatulate to falcate, subequivalve; LV beak pointed, curved or straight, usually not projecting beyond that of RV; area of attachment negligible; LV area high and narrow but sometimes broad and short; length of resilifer nearly equal to or slightly less than that of bourrelet; umbonal cavity deep; LV commisural shelf with rounded gutter generally well developed and may extend only up to the adductor muscle; chomatal pits encircle the valve margin, ventral ones being sometimes weak; both valves with concentric fairly smooth and undulatory growth striae, radial ornament totally absent.

Horizon: Cenomanian to Maestrichtian.

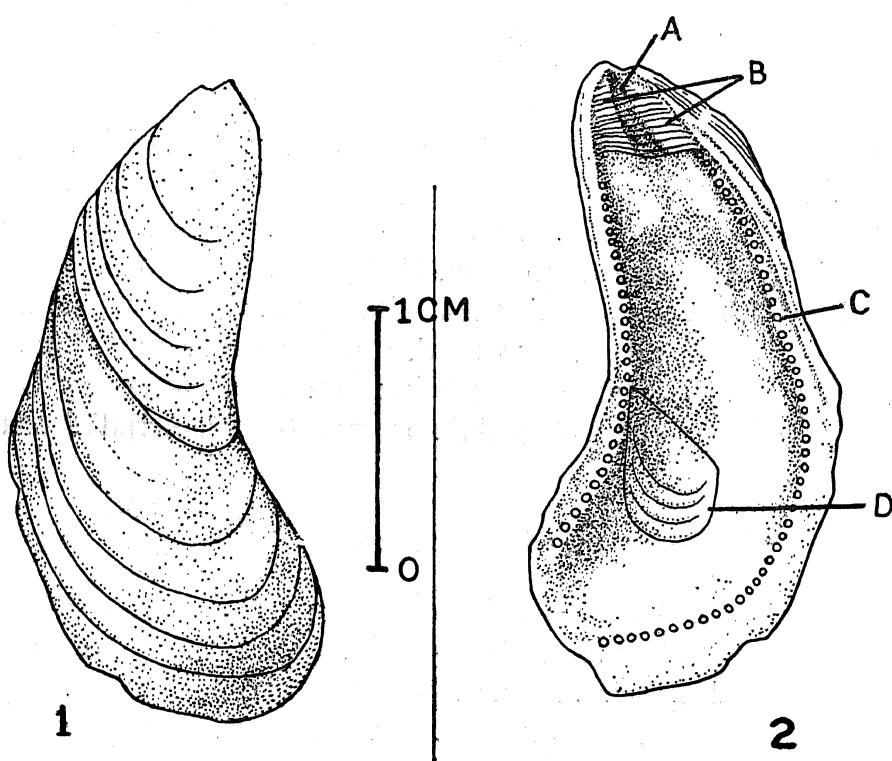
REMARKS: All the known species of this genus, those described here as well as those cited below as probably falling under this genus, are small sized. By its general appearance and broad morphological features, this genus closely resembles the upper cretaceous nonincubatory genus *Acostrea* Vyalov, 1936 (Stenzel 1971, p. 1128, figure J 100). But its small size resilifer equal to or even smaller than the bourrelet, chomatal pits encircling the entire valve margin and total absence of radial ornament distinguish this genus.

Chomatal pits encircling the valve margin is the only point of similarity this genus has with another nonincubatory genus *Saccostrea* Dolffus and Dangerberg ranging from Miocene to Recent.⁸

Chomatal pits encircling the valve margins, absence of radial ribs and narrow ligamental area distinguish this genus from *Crassostrea* Sacco.⁸

Curvostrea Vyalov⁸ shows striking similarities with some species of the present genus. But a meticulous examination would reveal that in *Curvostrea* the area of attachment is distinctly well developed; also the area of maximum tumidity extends from the umbo to the ventral margin in the form of a distinctive ridge like feature with the shell surface sloping steeply on either side of it.

As mentioned in the descriptive part that follows some of the Bagh species are comparable to species like *Ostrea isidis* Fourtau, *O. rouvillei* Coquand, *O. crenulimarginata* Gabb, *O. boucheroni* Coq. and *Gryphaea arrialoorensis* Stol. If internal details such as their musculature, chomatal pits, resilifer, gutter on the commisural shelf are known these species could be placed under the new genus proposed here.



Text-figures 1 and 2. *Indostrea indica* gen. et. sp. nov; 1. Side view of LV showing ornament; 2. Internal view of LV: A. Area of resilifer; B. Area of bourrelets, C. Catachomata, D. Posterior adductor muscle imprint.

3. (A) *Indostrea indica* SP. NOV.

Plate I, figures 1-24, text-figures 1, 2 and 3.

MATERIAL: Large number of specimens, *Holotype* No. Bad 9/73

Paratype Nos. KH 41, Bad 201/73, Bad 1/73, Bad 5/73
Bad 2/73, Bad 7/73, Mor 15/69, Bad 8/69,
Bad 6/69, Bad 3/73, Bad 4/73 and Bad 98/69

DIMENSIONS:

Specimen No.	Height mm	Length mm	H/L
Bad 9/73	24	9	2.7
Bad 1/73	43	15	2.8
Bad 98/69	33	12	2.7
Bad 7/73	34	13	2.6
Bad 2/73	36	13	2.7

DESCRIPTION: The shell is small sized and usually falcate but spatulate forms are also present (Bad 2/73, Bad 1/73, Bad 7/73, etc.). LV is convex and RV flat to slightly depressed in the ventral region in grown up individuals. In fully grown up individuals much of the ventral half of the shell is highly compressed giving the appearance of a knife-blade (Bad 2/73, Bad 1/73, etc.). Umbones are terminal, pointed and feebly turned posteriorly. The concentric growth striae are less conspicuous on RV. Some individuals have their dorsal region turned towards the anterior side resulting in a sigmoid outline (Bad 4/69, Bad 3/69). The ligamental area is triangular and higher than long and the resilifer is almost equal to the bourrelet. Posterior adductor muscle mark is close to the posterior margin and ventrally with respect to the centre of the shell; it is comma shaped with dorso-posterior end drawn out. Chomatal pits are well developed up to the muscle mark, beyond which they are less prominent. Relict chomata are observable in the RV (Bad 201/73).

In spite of considerable variation in the outline shown by the adults of this species they can be identified as belonging to this species by studying the series of changes in their outline starting from the very young stage with its posterior margin straight, and anterior and ventral margins extending out to give the shell spatulate to falcate shape of the adult stage (text-figure 3).

Ostrea rouvellei Coquand reported to occur widely in the Cenomanian to Maestrichtian strata in northern and western African regions, Peru and

Kathiawar in India⁹⁻¹³ is very much like the present species, which however, has its ventral portion highly compressed characteristically into a blade like edge. However, information on the internal features of *O. rouuellei* is still not available.

It may be incidentally mentioned here that Greco¹⁰ has taken *O. rediviva* Coq. as synonymous with *O. rouuellei* Coq. But we think that except the specimen shown in Greco's figures 6-9 on Plate I other specimens differ from *O. rouuellei* in their shape, tumidity, area of attachment, etc.

OCCURRENCE: oyster Bed at the top of Upper Coralline Limestone at Badia and the oyster bed at the top of Nimir Sandstone at Mongra, Khadlu and Moti Chikli.

3 (B) *Indostrea ampulliformis* SP. NOV.

Plate I, figures 25-30, text-figure 4.

MATERIAL: Four specimens, *Holotype* No. Bad 27/73,

Paratype Nos. Bad 59/69, Bad 28/73.

DIMENSIONS

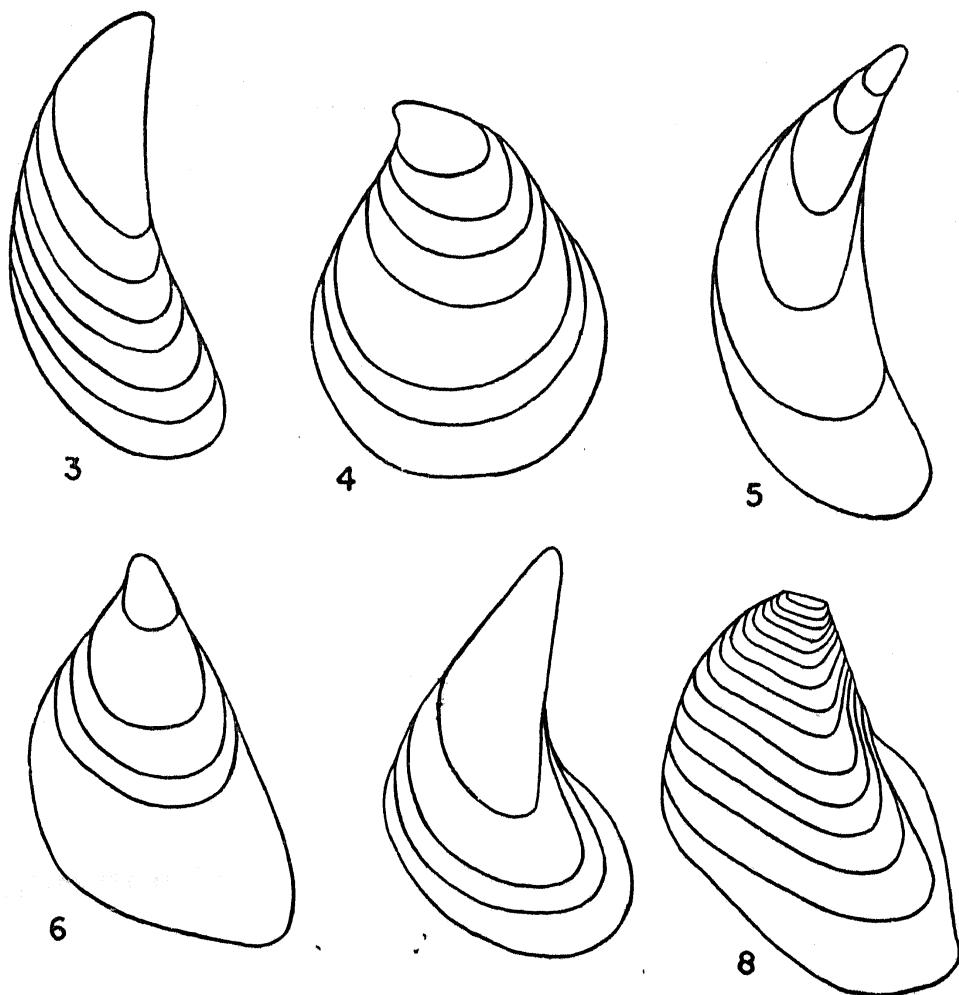
Sp. No.	Height mm	Length mm	H/L
Bad 27/73	23	16	1.44
Bad 28/73	16	11	1.45
Bad 59/69	20	13	1.54

DESCRIPTIONS: The shell is variable in outline but commonly oval as revealed by studying the growth stages which start with a subcircular outline. Umbones are pointed and ophisthogyrall. Surface is somewhat uneven as some of the growth stages are markedly strong. Like other species of this genus this species also has no ornamentation except the concentric growth stages and very fine concentric striae.

The ligamental area is broadly triangular. Adductor muscle mark is comma shaped and situated slightly dorsal to the center of the valve.

REMARKS: As compared to the associated species the present one is characterised by uneven surface and ampulliform outline at the early growth stages (text figure 4).

OCCURRENCE: Oyster Bed coming at the top of Upper Coralline Limestone at Badia.



Text-figures 3-8. Showing successive growth stages of: 3. *Indostrea indica* sp. nov.; 4. *Indostrea ampulliformis* sp. nov.; 5. *Indostrea falciformis* sp. nov.; 6. *Indostrea hemispherica* sp. nov., 7. *Indostrea reniformis* sp. nov. 8. *Indostrea deflecta* sp. nov.;

3 (c) *Indostrea obclavata* SP. NOV.

Plate II, figures 30-34.

MATERIAL: Four specimens, Holotype No. Mor 170/69.

Paratype Nos. Mor 171/69, Mor 169/69, and Mor 168/69.

DIMENSIONS

Sp. No.	Height mm	Length mm	Thickness mm	H/L	L/T
Mor 170/69	29	5	8	6	0.6
Mor 168/69	27	7	7	4	1

DESCRIPTION: All the specimens have their valves closed. Shell is obclavate to falciform, slightly curved and with pointed umbones. LV
B4—June 1976

is highly tumid. RV is flat. Chomatal pits are seen as relict chomata (Mor 171/69, Mor 168/69).

REMARKS: This species has close resemblance to *Indostrea falciformis* (*vide infra*) in outline but differs by its shell being highly tumid, and also higher H/L ratio.

OCCURRENCE: Oyster Bed coming towards the top of the Nimar Sandstone at Mongra.

3 (D) *Indostrea falciformis* SP. NOV.

Plate II, figures 22-29, text-figure 5.

MATERIAL: Large number of specimens, *Holotype* No. Bad 22/73, *Paratype* Nos. Bad 21/73, Bad 23/73, Bad 24/73 and Bad 26/73.

DIMENSIONS:

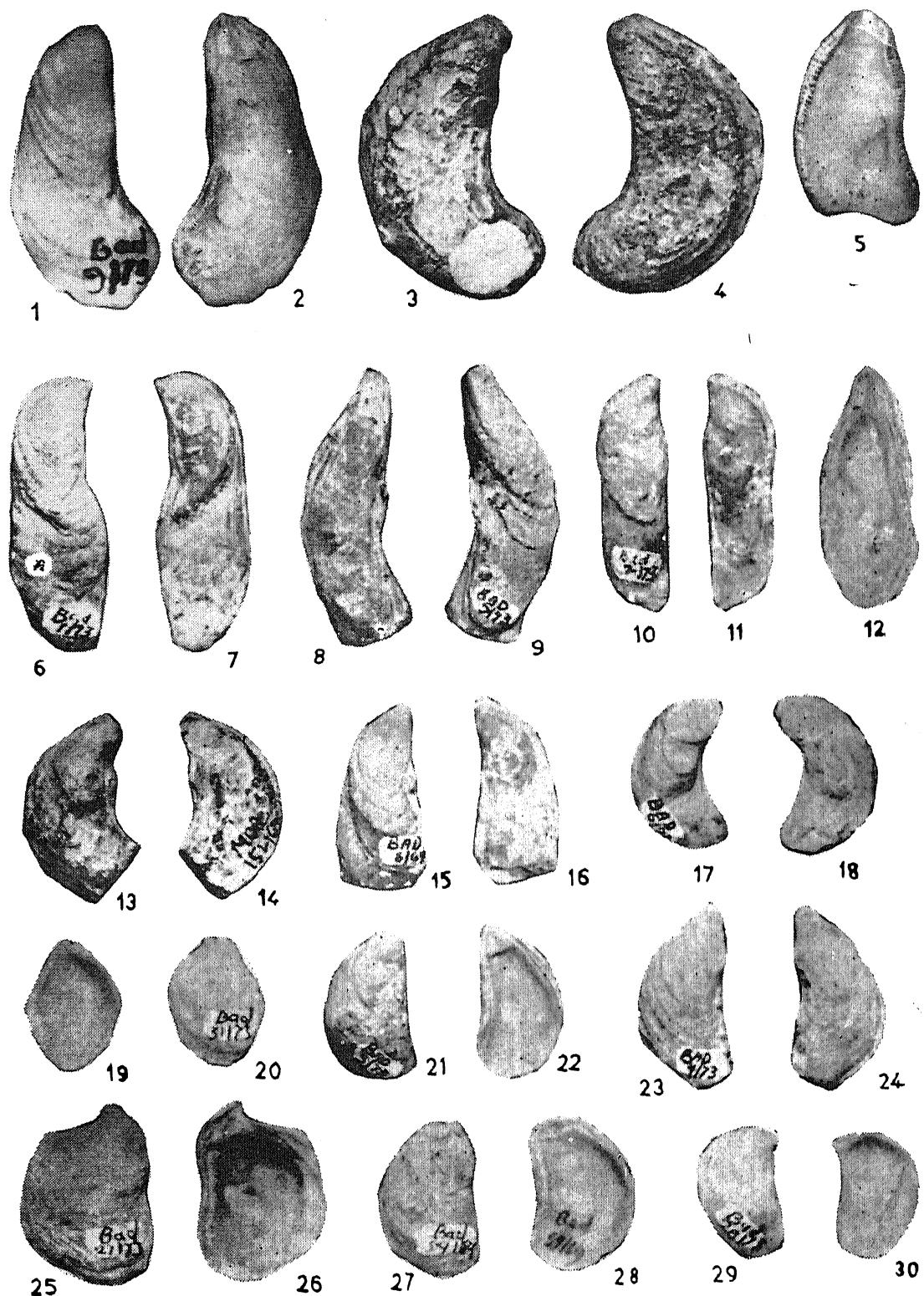
Specimen No.	Height mm	Length mm	H/L
Bad 22/73	24	8	3
Bad 23/73	22	7	3
Bad 24/73	21	8	2.6
Bad 26/73	24	8	3

DESCRIPTION: The shell is tall and falcate in outline. Umbones are pointed and slightly ophisthogyrus or straight.

The shell has persistent tendency to bend posteriorly, and thus develops sickle shape as its typical nature (Plate II, figures 22 and 24). But for growth laminae and the concentric striae the shell is smooth. The comma shaped muscle mark is subcentral in position. The chomata well developed all along the valve margin.

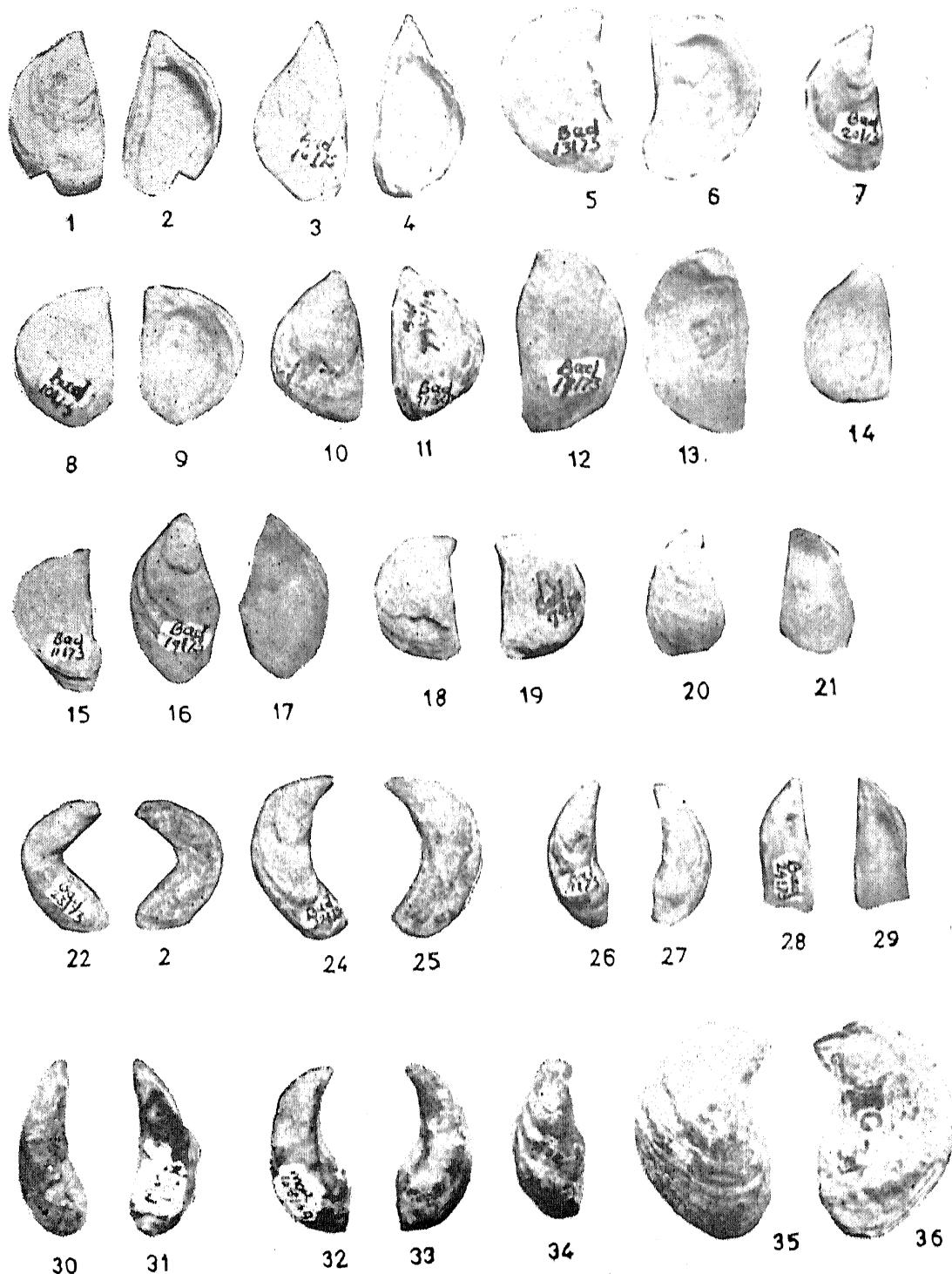
REMARKS: By its falcate outline, acuminate and triangular ligamental area, and tall shell the present species is closely comparable to *O. isidis* Fourtau from Cenomanian of Egypt¹⁴ but the obvious difference is that Fourtau's species is much taller, has its muscle mark ventral to the centre of the shell. Fourtau's species as illustrated in figure 5 on Plate II shows a few chomatal pits, which, however, are developed only up to the muscle mark.

On the whole the external and internal characters show that *O. isidis* Fourtau can be placed under our new genus.



Figures 1-30

(facing page 250)



Figures 1-36

(facing page 251)

The juvenile growth stages of the present species show (text-figure 5) a pear-shaped outline having anterior and posterior sides almost symmetrically convex, and thus it differs from *Indostrea indica* (*vide supra*) which is characterised by a nearly straight posterior margin.

OCCURRENCE: Oyster Bed coming at the top of Upper Coralline Limestone at Badia.

3 (E) *Indostrea hemisphaerica* SP. NOV.

Plate II, figures 1 to 21, text-figure 6.

MATERIAL: Large number of specimens, Holotype No. Bad 14/74

Paratype Nos. Bad 10/73, Bad 11/73, Bad 12/73, Bad 13/73,

Bad 15/73, Bad 16/73, Bad 17/73, Bad 19/73,

Bad 20/73, Bad 74/69, Bad 152/69.

DIMENSIONS

Specimen No.	Height mm	Length mm	H/L
Bad 14/73	20	13	1.5
Bad 16/73	29	16	1.8
Bad 152/69	24	15	1.6
Bad 11/73	23	14	1.6

DESCRIPTION: The shell is tall with the posterior side straight and the anterior side joining the ventral side in a smooth uniform curve to give the shell an outline somewhat variable from subcircular to elongately oval.

Internally, the left valve shows all typical characters of this genus.

REMARKS: Like *Indostrea indica* (*vide supra*) this species has a straight posterior margin to begin with but quite different outline, being semicircular or pearshaped, more or less persistent from early to adult stages (text-figure 6).

Ostrea crenulimarginata Gabb from Campanian of Tennessee (Coquand 1862, page 57, plate 12, figure 13) is by its outline and chomatal pits is like our *Indostrea hemispherica* (Bad 19/73, Bad 12/73, etc). That Stenzel has reported as *Ostrea* (*Ostrea*) *crenulimarginata* (Stenzel 1971, p. 993); its external characters are not shown by Coquand. In case it is found to be devoid of radial ornament it would be placeable under this new genus.

Ostrea boucheroni Coq. has shell outline like the present species, in fact to a greater extent than *O. crenulimarginata*, but in our species the posterior

side is straight and the anterior and ventral margins merge smoothly. While in case of *O. boucheroni* (Coquand 1869, figures 4 and 6, plate 37) it is the anterior margin that is straight, and the posterior and ventral margins merge into one another in a continuous curve. Besides, internal details of *O. boucheroni* Coq. are not known except only vaguely from the description given by Abbass (1962, page 76, Plate 10, figures 3, 6 and 8).

OCCURRENCE: Oyster Bed coming towards the top of Upper Coralline Limestone at Badia.

3 (F) *Indostrea reniformis* SP. NOV.

Plate III, figures 1-6 and 16-19, text figure 7.

MATERIAL: Large number of specimens, Holotype No. Mor 144/69

Paratype Nos. Mor 148/69, Mor 161/69, Mor 151/69, Mor 141/69

Bad 200/69, Bad 20/69

DIMENSIONS

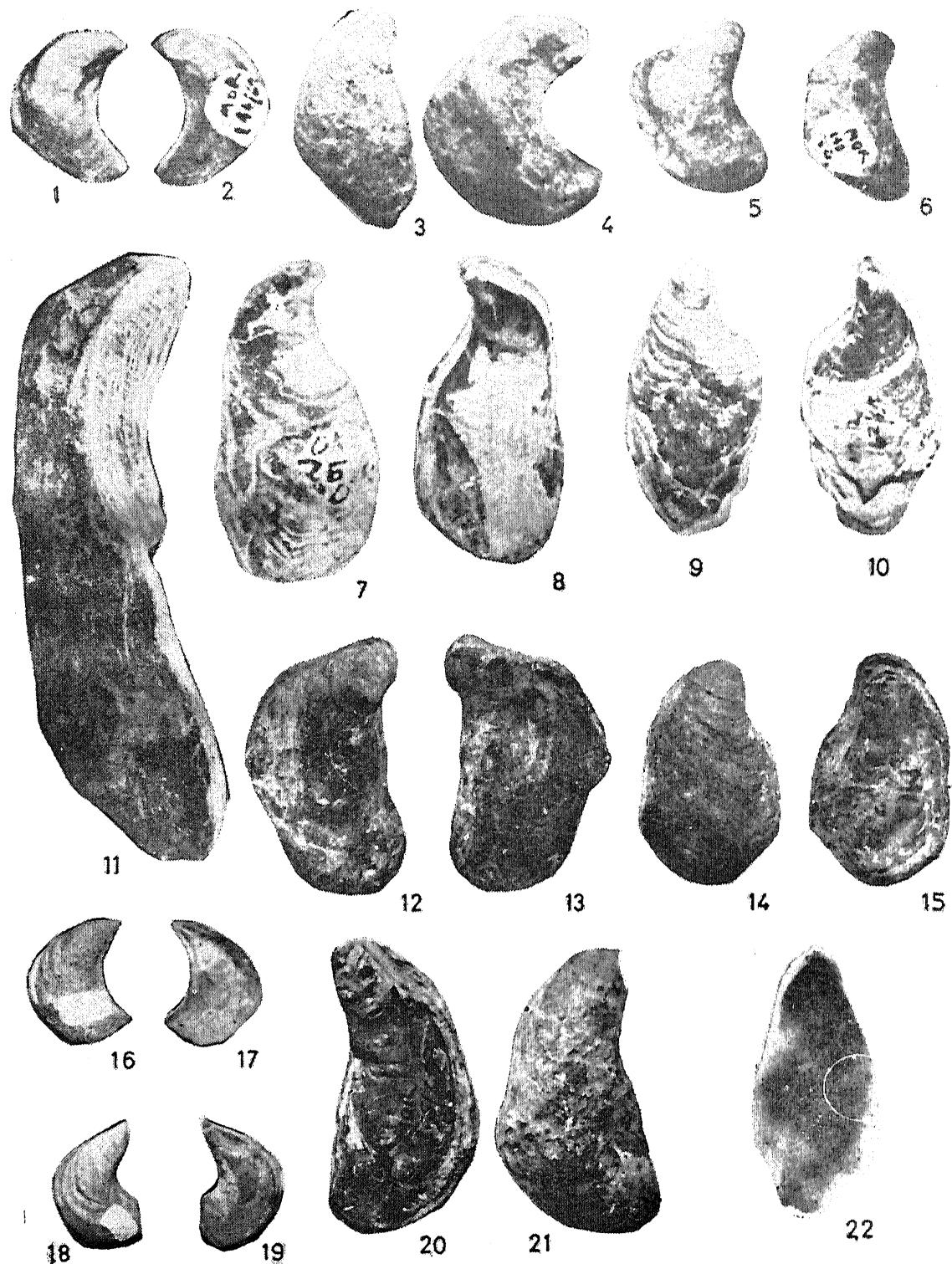
Sp. No.	Height mm	Length mm	H/L
Mor 144/69	25	15	1.6
Mor 161/69	52	22	2.4
Bad 200/69	30	13	2.3
Bad 201/69	33	14	2.3

DESCRIPTION: This species though somewhat variable in outline has mostly a kidney-shaped shell owing to turning of both the dorsal and ventral sides.

It has pointed terminal umbones. Ligamental area is triangular, acuminate or broad. The muscle mark is comma shaped and situated along the posterior margin. The chomatal pits are seen as catachomata in sp. No. Mor 141/69 and as relict chomata in sp. No. Mor 144/69.

REMARKS: The general aspect of the present species and *Curvostrea rediviva*^{8,15} from Cenomanian of Constantine are very strikingly similar. But nothing is known about the internal characters of the Constantine species. The ridge going from umbo to ventral margin is not developed in the present species nor does it have attachment area any way comparable to that of *Curvostrea rediviva*.

OCCURRENCE: Oyster Bed coming at the top of Nimar Sandstone at Mongra and Khadlu; Oyster Bed coming at the top of Upper Coralline Limestone at Badia.



Figures 1-22

(facing page 252)

3 (G) *Indostrea deflecta* SP. NOV.

Plate II, figures 35–36, Plate III, figures 7–15 and 20–22 text figure 8.

MATERIAL: Large number of specimens; *Holotype* No. Okh 25/69

Paratype Nos. Mo 31, Mor, 162/69, Mor 155/69, Mor 50/69
Mor 160/69, Mor 35, Mor 33, Mo 33.

DIMENSIONS

Sp. No.	Height mm	Length mm	H/L
Okh 25/69	48	23	2
Mor 33	46	21	2.2
Mor 35	43	20	2.1
Mor 46/69	36	19	1.9
Mor 160/69	45	24	1.9

DESCRIPTION: With an initial squarish outline the shell grows in the postero-ventral direction giving to the middle growth stages a sickle-shaped outline, but in later stages it grows almost at right angle to the dorsal margin, the posterior side thus acquiring 'S' shaped outline (text-figure 7). LV is convex with point of maximum convexity lying in the centre; RV is flat to slightly concave.

Rugose nature of the growth laminae and 2–4 fine concentric striae between growth stages constitute the ornament.

As all the specimens of this species are closed shells an attempt was made to see if x-ray photo could be helpful in studying the internal details. The trials taken so far are promising. As deciphered from the x-ray picture* of specimen No. Mor 160/69 the muscle mark is comma shaped and subcentral in position. The development of the chomatal pit is noticeable in the form of relict chomata along the valve margin (Paratype No. Mor 162/69).

REMARKS: The squarish outline at early growth stage and sudden change in the direction of growth at later stage are features not seen in any of the associated species.

Though at early stage this species resembles *G. arrialoorensis* Stol.¹⁶ they differ at later stages; also internal details of the South Indian species are not known.

* As the x-ray negative is found to get a tolerably clear print, the nature and the location of the muscle mark are made noticeable by a white circle in Fig 22, Pl. III.

OCCURRENCE: Oyster Bed coming towards the top of Nimar Sandstone at Mongra, Khadlu and Moti Chikli.

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EXPLANATION OF PLATES

(All figures are of natural size except where otherwise indicated)

PLATE I

Indostrea indica GEN et. SP. NOV.

Figures 1-18 and 21 to 24.

Figures 1 and 2: Geno Holotype No. Bad 9/73; 1. Side view of LV. $\times 2$; 2. Internal view of LV. $\times 2$.

Figures 3 and 4: Paratype No. KH 41; 3. Side view of LV; 4. Side view of RV.

Figure 5. Paratype No. Bad 201/73; Internal view of RV showing anachomata, $\times 2$.

Figures 6 and 7: Paratype No. Bad 1/73; 6. Side view of LV; 7. Side view of RV.

Figures 8 and 9: Paratype No. Bad 5/73; 8. Side view of RV; 9. Side view of LV.

Figures 10 and 11: Paratype No. Bad 2/73; 10. Side view of LV; 11. Side view of RV.

Figure 12. Paratype No. Bad 7/73; Internal view of LV.

Figures 13 and 14: Paratype No. Mor 15/69; 13. Side view of LV; 14. Side view of RV.

Figures 15 and 16: Paratype No. Bad 8/69; 15. Side view of LV; 16. Side view of RV.

Figures 17 and 18: Paratype No. Bad 6/73; 17. Side view of LV; 18. Side view of RV.

Figures 21 and 22: Paratype No. Bad 3/73; 21. Side view of LV; 22. Internal view of LV

Figures 23 and 24: Paratype No. Bad 4/73; 23. Side view of LV; 24. Side view of RV.

Indostrea ampulliformis SP. NOV.

Figures 19-20 and 25-30.

Figures 19 and 20: Paratype No. Bad 31/73; 19. Internal view of LV; 20. Side view of LV.

Figures 25 and 26: Holotype No. Bad 27/73; 25. Side view of LV, $\times 1.3$; 26. Internal view of LV, $\times 1.3$.

Figures 27 and 28: Paratype No. Bad 59/69; 27. Side view of LV, $\times 1.3$; 28. Internal view of LV, $\times 1.3$.

Figures 29 and 30: Paratype No. Bad 28/73; 29. Side view of LV, $\times 1.3$; 30. Internal view of LV, $\times 1.3$.

PLATE II

Indostrea hemispherica SP. NOV.

Figures 1-21

Figures 1 and 2: Holotype No. Bad/14/73; 1. Side view of LV; 2. Internal view of LV.

Figures 3 and 4: Paratype No. Bad 16/73; 3. Side view of LV; 4. Internal view of LV.

Figures 5 and 6: Paratype No. Bad 13/73; 5. Side view of LV; 6. Internal view of LV.

Figure 7. Paratype No. Bad 20/73 Side view of LV.

Figures 8 and 9: Paratype No. Bad 10/73; 8. Side view of LV; 9. Internal view of LV.

Figures 10 and 11: Paratype No. Bad 152/69; 10. Side view of LV; 11. Side view of RV.

Figures 12 and 13: Paratype No. Bad 17/73; 12. Side view of RV; 13. Internal view of LV.

Figures 14: Paratype No. Bad 15/69, Internal view of RV.

Figure 15: Paratype No. Bad 11/73, Side view of LV.

Figures 16 and 17: Paratype No. Bad 19/73; 16. Side view of LV; 17. Internal view of LV.

Figures 18 and 19: Paratype No. Bad 74/69; 18. Side view of LV; 19. Side view of RV.

Figures 20 and 21: *Indostrea hemispherica* sp. nov. Paratype No. Bad 12/73; 20. Side view of LV; 21. Internal view of LV.

Figures 22-29

Figures 22 and 23: Paratype No. Bad 23/73; **22.** Side view of LV; **23.** Side view of RV.
Figures 24 and 25: Holotype No. Bad 22/73; **24.** Side view of LV; **25.** Side view of RV.
Figures 26 and 27: Paratype No. Bad 21/73; **26.** Side view of LV; **27.** Side view of RV.
Figures 28 and 29: Paratype No. Bad 24/73; **28.** Side view of LV; **29.** Internal view of LV.

Indostrea obclavata sp. nov.

Figures 30 to 34

Figures 30 and 31: Holotype No. Mor 170/69; **30.** Side view of LV; **31.** Side view of RV.
Figures 32 and 33. Paratype No. Mor 168/69; **32.** Side view of LV; **33.** Side view of RV.
Figure 34: Paratype No. Mor 169/69, Side view of LV.

Indostrea deflecta sp. nov.

Figures 35 and 36: Paratype No. Mo 31; **35.** Side view of LV; **36.** Side view of RV.

PLATE III

Indostrea reniformis sp. nov.

Figures 1-6 and 16-19.

Figures 1 and 2: Holotype No. Mor 144/69; **1.** Side view of LV; **2.** Side view of RV.
Figure 3. Paratype No. Mor 148/69, Side view of LV.
Figure 4. Paratype No. Mor 161/69, Side view of LV.
Figure 5. Paratype No. Mor 151/69, Side view of LV.
Figure 6. Paratype No. Mor 141/69, Side view of LV.
Figures 16 and 17. Paratype No. Bad 200/69; **16.** Side view of LV; **17.** Internal view of LV
Figures 18 and 19: Paratype No. Bad 201/69; **18.** Side view of LV; **19.** Side view of RV.

Indostrea deflecta sp. nov.

Figures 7-15 and 20-22.

Figures 7 and 8: Holotype No. Okh 25/69; **7.** Side view of LV; **8.** Side view of RV.
Figures 9 and 10: Paratype No. Mor 162/69; **9.** Side view of LV; **10.** Side view of RV.
Figure 11. Paratype No. Mor 155/69, Posterior view showing relict chomata, $\times 2$.
Figures 12 and 13: Paratype No. 50/69. **12.** Side view of LV; **13.** Side view of RV.
Figures 14 and 15: Paratype No. Mor 33; **14.** Side view of LV; **15.** Side view of RV.
Figures 20 and 21: Paratype No. Mor 155/69; **20.** Side view of RV; **21.** Side view of LV.
Figure 22. X-ray picture of Paratype No. Mor 160/69. Position of posterior adductor muscle as revealed by x-ray picture is shown by white ring.